THERMOELECTRICS IN EMISSIONS REDUCTION

John C. Bass
Hi-Z Technology, Inc.

Several after-treatments that are currently being developed to reduce both No_x and particulate emissions from Diesel engines require power from the truck's electric system. The amount of power required varies from several hundred Watts to a few kilowatts, depending on the process involved. This power demand will lead to increased fuel consumption and therefor increased operating cost if this power is obtained from the truck's alternator.

One of the facts about truck engines is that they typically exhaust about as much energy as that is being supplied as engine mechanical output. In addition, this energy is high grade energy which can be readily converted to additional output power. Attempts have been made to recover this waste energy in the past. These methods include turbo-compounding and more recently, the direct conversion of heat to electricity via thermoelectrics.

Thermoelectric conversion requires only that one establish a temperature difference across the thermoelectric material. The principles behind this technology were first established in the early nineteenth century. At that time metals were used for the thermocouples which had very low conversion efficiencies because of their high thermal conductivity. The discovery of semiconductors and their application to thermoelectrics in the 1950's improved the conversion efficiency of thermoelectric systems and led to their use in space power applications.

Not much change was seen in the field of thermoelectrics until the mid 1990's when the potential use of quantum well materials in thermoelectrics was discovered. This new class of materials has the promise of heat-to-electric conversion efficiencies that appear to be competitive with many of the conventional heat engines in use today.

The use of solid state thermoelectrics to convert waste heat from the engine directly to electricity for NO_X and particulate reduction systems seems to follow naturally. These systems can be used to clean up the engine's exhaust without penalizing the truck operator with increased fuel consumption and higher operating cost.

Hi-Z has recently completed successful testing of its 1 kW thermoelectric generator in a test cell on both 10 and 14 liter engines. We are currently involved in testing this same generator over-the-road prior to integrating the unit into the truck system. This generator was built using conventional bismuth-telluride thermoelectric semiconductor alloys.

In the near future we expect to start work designing a generator for a combined thermoelectric/NO_x and particulate reduction system for trucks. This unit will be designed to supply all of the power required by the emissions reduction system without impacting the truck's fuel economy.

Meanwhile we are pursuing the development of new thermoelectric materials to improve the thermal-to-electric conversion efficiency and reduce their cost. We feel that the significantly increased efficiency that can be achieved by the development of these new materials will lower the cost of thermoelectric systems. This development will lead to their general use in the trucking industry, not only for emissions reduction, but also for other applications such as alternator replacement or supplementation in a truck with more electrically driven auxiliaries, or provide power for such systems as self-powered truck preheaters and air conditioning systems. All of these new systems will be designed to utilize waste heat and reduce truck emissions while decreasing the operating cost of the truck of the future.